A Primer

Basic concepts and terms used in economic theory are presented in this chapter to help explain their use and importance in fisheries management. These terms are used throughout the report and provide some context for the relevance and usefulness of economics in understanding why and how fisheries can be managed for sustamable economic health.

Economics is the study of how individuals, firms, nations, and societies allocate scarce resources among unlimited wants. Allocation is the process of distributing resources such as labor, capital, and natural resources among uses and/or users. Since much of economics relies on the concepts of supply and demand, these terms are defined first.

Supply is a relationship which characterizes the amount of a good that producers would supply at each price. All else equal, the higher the price, the more producers are willing to supply. A supply curve (Fig. l-l) graphically traces the incremental or marginal cost of producing a good for each level of production. Marginal cost refers to the additional cost of producing one more unit of a good. The supply curve is thus a marginal-cost curve. In fisheries, the supply curve can refer to a number of things: the supply of landings to processors, the supply of processed seafood products to consumers, or the supply of charter boat and party boat trips to recreational fishermen, for example. The term "cost effective" means that a particular level of a good is produced in the least costly method. Sometimes a distinction is made between private and social costs; social costs are those costs that are incurred by society from producing a good or service, while private costs are those incurred by an individual firm. For example, a firm that is allowed to pollute the environment in the course of its normal operations incurs only the costs of producing its product; the social cost of that production includes the cost of cleaning up the pollution or the costs of dealing with the consequences of the pollution.

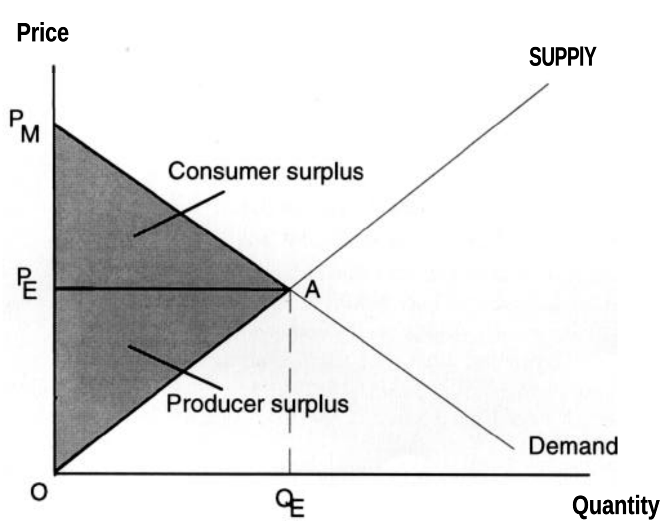

Figure l-l
Consumer surplus and producer surplus: traditional measures.

The measure used to evaluate the benefits to producers or suppliers of a good is called producer surplus (PS), or rent, and is defined as the difference between total revenues (sales or gross value of production) and the total variable costs of production. Variable costs are those that vary with the level of production (e.g., expenditures on fuel); fixed costs are those that are incurred regardless of the level of production (e.g., an insurance premium on a vessel). Profits arc the difference between total revenues and total costs, which include both variable and fixed costs. Graphically, producer surplus is represented by the triangular area OPuA.

Demand is a relationship that characterizes the amount of a good that consumers would purchase at each different price. The higher the price, the less consumers are willing to buy. Graphically, the demand curve traces the price consumers are willing to pay for each additional, or marginal, unit of a good (Fig. l-l). A benefit is the satisfaction or utility a consumer receives from consuming a bundle of goods or services. Marginal benefit refers to the additional satisfaction gained from consuming one more unit of a good or service. The demand curve is thus a marginal benefit curve, and willingness to pay (WTP) is the total area under a demand curve. The concept of demand in fisheries can refer to a number of markets: the retail demand for seafood, producers' demand for harvested fish, or the demand for recreational fishing experiences. As with costs, there is a distinction between private and social benefits. Social benefits are the benefits accrued to society from the production of a good or service, while private benefits accrue to an individual consumer.

Consumer surplus (CS) is a measure of the net economic benefits to consumers from purchasing a good or service and it is defined as the difference between what a consumer would have been willing to pay for a good and the amount actually paid. Consumer surplus (area P_EP_MA in Fig. 1-1) is calculated as the total area under a demand curve up to the equilibrium quantity of a good (area OP_MAQ_E) less the total expenditure for that quantity (area OP_EAQ_E).

The demand and supply curves can indicate the responsiveness of consumers and producers to price changes. When a 1% change in price causes an increase or reduction in quantity purchased of more than 1% (or when the slope of the demand curve is relatively flat), demand is said to be price elastic. When a 1% change in price causes a change in quantity purchased of less than 1% (i.e. the slope of the demand curve is relatively steep), demand is said to be price inelastic. Similarly, supply is said to be price elastic (inelastic) when a 1% change in price leads to a change in quantity supplied by producers of more than (less than) 1%. Estimates of price elasticity are useful for determining the magnitude of changes in consumer and producer surplus when prices, or factors which might affect price, change.

Net economic benefits (NEB) are the sum of consumer and producer surpluses and represent the difference between the total benefits and total costs of an action. Net economic benefits are maximized when all resources have been allocated to their best use. Net present value (NPV) is a sum which reflects the value in today's dollars (i.e. discounted to the present time period) of net economic benefits that accrue over a period of time. Discounting reflects the rate of return that society is willing to accept or trade for sacrificing present consumption. The lower the discount rate, the more weight society places on future periods, and hence the more likely society will be to sacrifice consumption in the present time period. Conversely, the higher the discount rate, the more society "prefers" the current time period and the less likely it is to sacrifice present consumption. NPV is usually used to calculate the value today of all future net economic benefits (benefits less costs).

Economic efficiency is said to occur when resource allocation is such that net economic benefits cannot be increased by changing that allocation. In commercial fisheries, this would occur when fishermen harvest a given amount of fish using the most cost-effective combination of capital, labor, and other inputs. Efficient allocation of resources typically occurs through market processes, and it ensures that resources are channeled to their most valuable uses and to those who value them the most. The opportunity cost of a resource is the value of that resource in its highest valued alternative use. For example, the opportunity cost of labor of a fisherman is the wage or salary that could be earned in another occupation. The opportunity cost of a commercial fishing vessel is the return that could be earned by selling the vessel and investing the money elsewhere. The opportunity cost of a fish harvested today is the value of that fish if it were left in the ocean. The opportunity cost of harvesting a fish today might be high if the fish could be sold for a higher price per pound later when it is larger. In addition, if harvesting today precludes the fish from reproducing, the value of its foregone offspring is also included in the opportunity cost.

A market is a mechanism for allocating goods and services and consists of the buyers and sellers of a good or service. The intersection of supply and demand determines the market, or equilibrium, price, P_E, and equilibrium quantity, Q_E, of a good. In Figure 1-1, this is point A. This is the point where price is equal to marginal cost. In commercial fisheries, the primary markets are: the ex-vessel market (sales between harvesters and processors), the processing or wholesale market (sales between processors and wholesalers or processors/wholesalers and retailers), and the retail market (sales between retailers and consumers). All three markets are interrelated; for example, consumers' demand for seafood affects processors' demand for fresh fish.

Markets may operate differently depending on the number of consumers and producers involved.

When there are a lot of consumers and producers, homogenous firms and products, and perfect information, a market is said to be perfectly competitive (or operating under perfect competition), and no individual buyer or seller can influence the market price or equilibrium quantity. If there is only one producer of a good, the market is said to be a monopoly, and the producer controls the equilibrium price or quantity of the good. When there is more than one producer, but still only a few, the market is called an oligopoly. An oligopsony is a market with relatively few consumers or buyers. In fisheries, this occurs more often in the processing sector, when only a few firms purchase and process a particular species. Oligopsony can lead to distortions in the ex-vessel market because those few processing firms are able to individually influence the prices paid to harvesters.

A market failure occurs when a market cannot or does not take into account all costs or benefits of producing or consuming a good. When this happens, outside intervention (usually undertaken by government) is required to correct the market failure if the goal is to ensure that resources are allocated efficiently. Inappropriate intervention can exacerbate a market failure or be the source of an allocation inefficiency.

An open-access resource is a resource that is not owned or controlled by anyone, while a common-property resource is controlled by a clearly defined set of users but is not owned or controlled by an individual. In an open-access fishery, no one owns the fish stock. That is, use or property rights do not exist for fish in the sea (fishermen do not have to pay to take a fish from the ocean). Use rights exist when there is a system for assigning ownership to all or part of a resource. The problem inherent in open-access fisheries was described succinctly by Gordon (1954), who wrote that a fisherman has little incentive to control fishing effort because ".. he who is foolhardy enough to wait for its proper time of use will only find that it has been taken by another."

Figure l-2 illustrates the classic economic textbook analysis of an open-access fishery. The concave curve is a total sustainable revenue (TSR) function, defining the revenues that could be earned on a recurring basis at every level of effort (E). The straight line extending from the origin is a total cost (TC) curve, showing the costs of harvest at each level of effort. In fisheries economics, the term capital generally refers to vessels and gear, while effort is a combination of vessels, gear, labor and time used to catch fish. Maximum Sustainable Yield (MSY) is at the highest point of the TSR curve. MSY is the term used to refer to the maximum level of harvest that can be taken with the same level of effort on a recurring basis. MSY is a result found only in simulat.ion models based on a Schaeffer or logistic biological growth model.

In open-access fisheries, theory predicts that effort levels will be at point EOA, where the total sustainable revenues from fishing effort equal total costs (or where rents are zero). At every point from E=O to EOA, total sustainable revenues are greater than total costs (the TSR curve lies above the TC curve at every point). In an open-access fishery, vessels will continue to enter the fishery as long as TSR>TC. Entry occurs up to the point where TSR=TC because fishermen only consider the private costs of harvest, not the social costs. This constitutes a market failure because the private costs of harvest are less than the social costs, which include the opportunity cost of all the resources used (including capital, labor, ‘and the fish themselves). A negative externality is said to exist when one individual’s or firm’s actions increases the costs or reduces the benefits of other individuals or firms. For example, if a firm deposits its wastes into a river which carries pollution downstream, and others have to clean the water before using it, the social costs may be greater

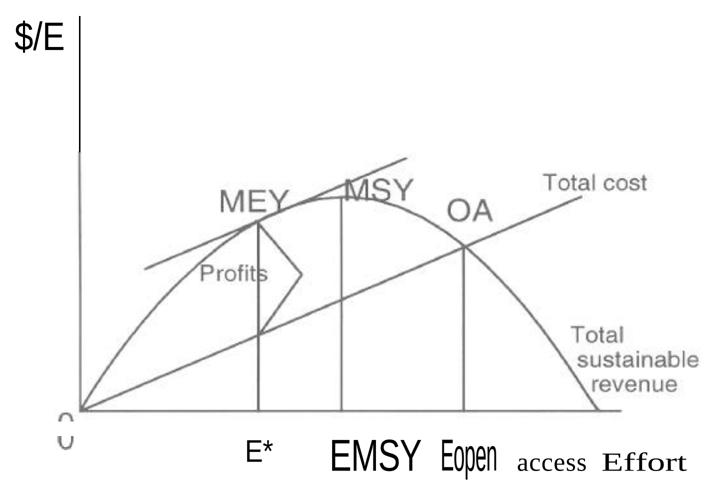

Figure l-2
Maximum economic yield, maximum sustainable yield, and open-access yield.

than the individual firm's (or private) costs of production. In open-access fisheries, a number of negative externalities can exist. Two of the more commonly analyzed externalities in fisheries are: crowding externalities, which occur when congestion from too many vessels on the fishing grounds causes the marginal cost of harvest to increase, and stock externalities, which occur when the entry of another vessel reduces the fish stock enough to affect other vessels' fishing costs. In both examples, fishermen do not consider the cost of their actions on other fishermen, even though their actions may increase the costs of all fishermen.

Maximum economic yield (MEY) is the term used to refer to the level of harvest that provides the maximum returns, or net economic benefits, to society. MEY is where the difference between the TSR and TC curves is at its greatest; profits are maximized here. It can be seen that at MEY the total cost curve is tangent to the TSR curve (i.e. their slopes are equal). This level is the most efficient because at this point the cost of using an additional unit of effort to harvest (the marginal cost of effort) just equals the additional, or marginal, revenue or satisfaction (the marginal benefits) from using it. Moving in either direction from MEY reduces profits. At this point, the social costs of harvest are taken into account. Society would be better off operating at this point, because all resources would be put to their highest valued use. Less effort could be used to harvest the same level of fish that results in open access, and at lower cost. In simple bioeconomic models, MEY is less than MSY, or, the economically sustainable level of effort is less than the biologically sustainable level. MSY has traditionally been the goal of fisheries management.

When effort and harvest in a fishery occur at any point greater than MEY (i.e. anywhere to the right of point E^*), the fishery is said to be overcapitalized. Overcapitalization exists when more capital than is needed is used to produce the optimal level of a good. In open-access fisheries, this usually refers to the excessive number and size of vessels, as well as the amount of gear, used to harvest fish. In most simple bioeconomic models, this is effort to harvest beyond MEY. Overcapitalization can represent an economic waste to society because the capital and labor needed to harvest at levels greater than MEY (such as at MSY) can be used in other sectors of the economy to produce goods and services whose net economic benefits exceed those generated by harvesting the few additional fish beyond MEY. Overcapitalization can also exist in the processing sector, as is the case when too many plants are built to process large quantities of fish in a short time and then lie idle for the remainder of the year, because the fish were harvested all at once in the race which often characterizes open-access fisheries.

Traditional fisheries regulations intended to restrict or reduce effort to the MSY level (often referred to as command-and-control methods) include catch quotas, trip limits, creel or bag limits, gear restrictions, limits on fish size, and time and area closures. These policy instruments can lead to biological improvements in stock levels in the short run, but they do so by effectively raising the cost of harvest at every level. This is equivalent to rotating the total cost curve in Fig. 1-2 up and to the left. While implementing policies like these might raise costs enough that the total cost curve is rotated all the way to the MEY point (E^*), doing this does not increase NEB's. That is, the total revenues still equal total costs at this point, so profits are still zero. In the long run, these methods generally do not sustain even the stock improvements because of the open-access market failure. That is, if the regulations are successful in improving stock levels in the short run, effort will eventually increase to take advantage of the improved stocks and catch rates. As long as profits exist (or TSR>TC), existing fishermen will find ways to increase effort or new vessels will enter the fishery, since the race to fish is not eliminated by these methods. The end result is greater catch and effort and a need to regulate further.

The economically sustainable level of effort and harvest can be achieved when clearly defined and enforceable use rights for fish in the ocean exist. A system of controlled access or the assignment of quasi-property rights corrects for some of the market failure of open-access fisheries by ensuring that the full cost of producing fish is incurred and that the supply curve accurately reflects the true costs of harvest to society. Quasi-property rights refer to a system that gives individuals the incentive to behave as if use rights to a resource exist, without the government actually surrendering its control of the resource. When this happens, the social cost of taking a fish from the ocean is said to be internalized by the fishermen. Giving fishermen the right to harvest a certain amount of fish, without restricting the method, time, or areas used, allows fishermen the flexibility to harvest how, when, and where they want. That is, when they are guaranteed a right to harvest a specified share of the fish stock, they will do so in the least-cost manner. The race to fish is thus eliminated. Monitoring the catch of individual fishermen and enforcement of catch quotas are key components to the success of any controlled access system. The system can only work if fishermen harvest the amount of fish for which they own rights.

In fisheries, the system of controlled access or quasi-property rights most commonly referred to is the Individual Transferable Quota (ITQ). ITQ's are essentially paper rights to a share of a particular fishery resource. Fishermen can sell their rights, use them by harvesting fish, or choose to hold them without harvesting. The value attributed to the use right, such as that gained by ownership of an ITQ share, represents the resource rent and reflects what fishermen are willing to pay to harvest that amount of the fish stock. Resource rent is the net revenue in excess of normal profits generated by the harvesting of fish that is due to the fish stock itself. In open-access fisheries, rent dissipation is said to occur because the value of the fish stock is not captured.

Two methods that can be used to assess different aspects of the economic consequences of government regulations are economic-impact analysis (EIA) and cost-benefit analysis (CBA). EIA is used primarily to measure how a proposed regulation will affect economic activity in a region or smaller locale in the immediate future. Links among industries are established, and the impacts on indicators such as expenditures, income, and employment in all sectors affected by the regulation are calculated. Purchases of goods and services necessary to harvest and process fish have direct impacts on the economy, whether from the commercial or recreational harvest sector. These purchases create revenues and employment in the vessel construction, labor, and other related support industries. In turn, the economic activity in these industries generates indirect impacts. For example, the purchases of labor, steel, and electronics required to build vessels create additional economic activity not directly associated with fish harvesting or processing. Finally, the incomes generated by these activities finance induced impacts, such as consumer purchases of food, housing, clothing, and entertainment. When a regulation changes the activity of individuals in any of these sectors, the effects "ripple" through the other sectors in the form of changes in expenditures, employment, and income. A good example of how EIA does not measure economic value is a natural disaster. When a hurricane, tornado, or earthquake strikes, there is usually a lot of money spent in the economy to recover from the damages incurred, but it would be hard to argue that society is better off (i.e. that NEB have increased) as a result of the disaster. Another example is an increase in fuel price; while expenditures for recreational fishing would increase, anglers would not necessarily be better off.

Cost-benefit analysis is used to determine whether there are positive net economic benefits from a proposed regulation. CBA is based on measuring and summing all of the costs and benefits associated with the regulation. If the costs of the regulation are less than the benefits (or the NEB are greater than zero), then the regulation is beneficial to society. CBA can also be used to compare the effects of alternative regulations: from the standpoint of economic efficiency, the regulation with the highest NEB is the most efficient and adds the most to the well-being of the Nation. CBA differs from EIA in that it can involve estimating the changes in consumer and producer surplus, rather than expenditures and employment, in all sectors affected by the regulation. In doing so, CBA takes into account whether resources are being put to their best use. In a sense, EIA determines where the gains and losses of the regulation occur by demonstrating how economic activity changes in each sector. CBA determines whether society could be better off from the regulation and whether resources are being efficiently allocated.

An example of the two methodologies may better illustrate the conceptual differences between them. Suppose the black sea bass recreational fishery closes and anglers shift all of their effort to fishing summer flounder. In terms of EIA, it would appear that no losses have occurred; expenditures on recreational fishing have not changed. However, angler consumer surplus (ACS) is reduced, because the opportunity to fish black sea bass is no longer there. We know that this opportunity had value to those anglers because they could have been fishing summer flounder, but chose not to until the black sea bass fishery closed. Summer flounder anglers might also experience a loss in ACS if catch rates fall as a result of the additional black sea bass anglers now in the fishery. CBA estimates the losses in consumer surplus for those anglers.

Now suppose that instead of switching to the summer flounder fishery, black sea bass anglers decide to spend all of their recreational money on bowling. Again, total expenditures in the economy do not change, but are merely transferred from the recreational fishing industry to the bowling industry. EIA would capture the shift in dollars spent in the economy, while CBA would capture the loss in consumer surplus to those anglers who can no longer fish for black sea bass.

In summary, this chapter has provided some of the basic terms and concepts that are useful for understanding and interpreting the information provided in the following chapters. Familiarity with terms like consumer and producer surplus, net economic benefits, open access, controlled access, market failure, and efficient resource allocation will make this document easier to read. Where possible, the report uses and applies these terms to provide information about the current economic health of the Nation's fisheries and to furnish reasons for trends in the various indicators used to assess health.

Literature Cited

Gordon, H. Scott.
1954. The economic theory of a common property resource. J. Polit. Econ. 62:124-42.